

CLAIMS:

1. A system for measuring a plasma electron density in a plasma chamber, the system comprising:

a plasma chamber containing a plasma;

a frequency source (a) for providing a decreasing frequency to the plasma chamber and (b) for providing an increasing frequency to the plasma chamber after providing the decreasing frequency;

a resonance frequency detector (a) for detecting a first set of resonance frequencies excited by the decreasing frequency and (b) for detecting a second set of resonance frequencies excited by the increasing frequency;

a comparator for determining a difference between a number of frequencies in the first and second sets;

a fringe order calculator for determining a fringe order of the plasma; and

a density calculator for determining a plasma electron density of the plasma based on the fringe order.

2. The system according to claim 1, wherein the frequency source comprises a voltage-controlled microwave oscillator.

3. The system according to claim 2, wherein the frequency source further comprises a digital-to-analog convertor for applying a voltage to the voltage-controlled microwave oscillator.

4. The system according to claim 1, wherein the plasma chamber comprises an open resonator immersed in a plasma.

5. The system according to claim 4, wherein the open resonator comprises plural reflectors, wherein all input and output connections are made to only one of the plural reflectors.

6. The system according to claim 1, further comprising a data input device for entering a desired plasma electron density.

7. The system according to claim 6, further comprising:

a plasma generator; and

an automatic controller for controlling the plasma generator to produce the desired plasma electron density based on the density calculated by the density calculator.

8. A method for measuring a plasma electron density in a plasma chamber, the method comprising the steps of:

- (a) providing a decreasing frequency to the plasma chamber via a frequency source;
- (b) providing, via the frequency source, an increasing frequency to the plasma chamber after providing the decreasing frequency;
- (c) detecting, via a resonance frequency detector, a first set of resonance frequencies excited by the decreasing frequency;
- (d) detecting, via the resonance frequency detector, a second set of resonance frequencies excited by the increasing frequency;
- (e) determining a difference between a number of frequencies in the first and second sets;
- (f) calculating a fringe order of the plasma; and
- (g) determining a plasma electron density of the plasma based on the fringe order.

9. The method according to claim 8, wherein the steps (a) and (b) comprise providing frequencies via a voltage-controlled microwave oscillator.

10. The method according to claim 8, wherein the steps (a) and (b) comprise providing frequencies to an open resonator immersed in a plasma.

11. The method according to claim 10, wherein the steps (c) and (d) comprise detecting from plural reflectors, wherein all input and output connections are made to only one of the plural reflectors.

12. The method according to claim 8, further comprising the step of inputting a desired plasma electron density.

13. The method according to claim 12, further comprising the steps of:
generating a plasma in a plasma generator; and
controlling the plasma generator to produce the desired plasma electron density based on the density calculated by the density calculator.